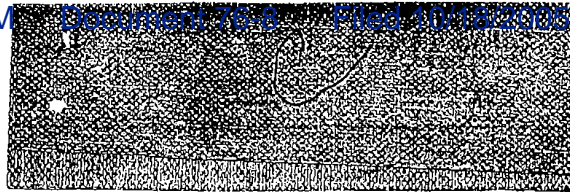



Jc135 U.S. PTO
09/368846
04/05/99

156	153	Subclass
Class	ISSUE CLASSIFICATION	



PATENT NUMBER
6514367

6514367

U.S. UTILITY PATENT APPLICATION

O.I.P.E. <i>AK</i>	PATENT DATE
SCANNED <i>CAS</i> O.A. <i>AK</i>	FEB 04 2003

SECTOR	CLASS 231	SUBCLASS	ART UNIT 2875	EXAMINER Astorgut
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ISSUING CLASSIFICATION									
ORIGINAL			CROSS REFERENCE(S)						
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INTERNATIONAL CLASSIFICATION									
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<input checked="" type="checkbox"/> TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Dwg. 4	Figs. Dwg. 11	Print Fig. 5	Total Claims 23	Print Claim for O.G. 1
<input type="checkbox"/> a) The term of this patent subsequent to _____ (date) has been disclaimed.	_____ (Assistant Examiner) (Date)			NOTICE OF ALLOWANCE MAILED 10-10-02	
	JEFF H. AFTERGUT PRIMARY EXAMINER GROUP 1300 Jeff H. Aftergut 10/1/02 (Primary Examiner) (Date)			ISSUE FEE Amount Due \$640.00 Date Paid 12/17/02	
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PATENT APPLICATION



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CONTENTS

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Class	Sub.	Date	Exmr.
156	277 153 555	11/30/00	JMF
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updated above 156	154	10/9/02	JMF

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
156	277 153 153 154	10/9/02	JMF

SEARCH NOTES
(INCLUDING SEARCH STRATEGY)

	Date	Exmr.
Reviewed parent files 08/918,582 08/727,789	10/9/02	JMF

POSITION	INITIALS	ID NO	DATE
FEE DETERMINATION	T.C.D.		8/11/99
O.I.P.E. CLASSIFIER	DN	32	8/15
FORMALITY REVIEW		21634	8/30/99

INDEX OF CLAIMS

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Claim	Final	Original	Date
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(12) **United States Patent**
Leighton

(10) **Patent No.:** **US 6,514,367 B1**
(45) **Date of Patent:** ***Feb. 4, 2003**

(54) **HOT LAMINATION PROCESS FOR THE
MANUFACTURE OF A COMBINATION
CONTACT/CONTACTLESS SMART CARD**

(76) Inventor: **Keith R. Leighton**, 2817 Fulmer Rd.,
Lorain, OH (US) 44053

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

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(21) Appl. No.: **09/368,846**

(22) Filed: **Aug. 5, 1999**

Related U.S. Application Data

(63) Continuation of application No. 08/918,582, filed on Aug.
19, 1997, now Pat. No. 6,036,099, and a continuation-in-part
of application No. 08/727,789, filed on Oct. 7, 1996, now
Pat. No. 5,817,207.

(60) Provisional application No. 60/024,255, filed on Aug. 21,
1996, and provisional application No. 60/005,685, filed on
Oct. 17, 1995.

(51) **Int. Cl.⁷ G06K 19/077**

(52) **U.S. Cl. 156/153; 156/154; 156/277**

(58) **Field of Search 156/277, 153,
156/555, 154; G06K 19/077**

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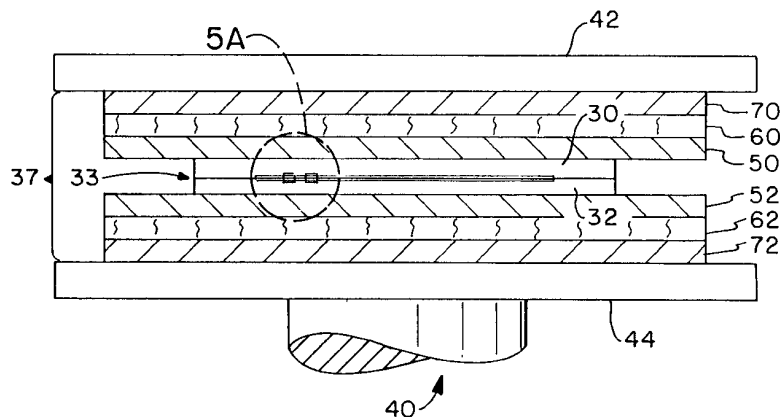
Primary Examiner—Jeff H. Aftergut

(74) *Attorney, Agent, or Firm*—Hahn, Loeser & Parks, LLP

(57) **ABSTRACT**

A plastic smart card, such as a card having a radio frequency
identification (RFID) proximity function, including at least
one electronic element embedded therein and a physical
contact card function and the hot lamination process for the
manufacture of this dual function smart card and other
plastic cards including a micro-chip embedded therein. The
process results in a card having a preferred overall thickness
in the range of 0.028 inches to 0.032 inches with a surface
suitable for receiving dye sublimation printing—the varia-
tion in card thickness across the surface should not exceed
0.0005 inches. A card manufactured in accordance with the
present invention also complies with all industry standards
and specifications. Also, the hot lamination process of the
present invention results in an aesthetically pleasing card.
The invention also relates to a plastic card formed in
accordance with the hot lamination process of the present
invention.

23 Claims, 4 Drawing Sheets

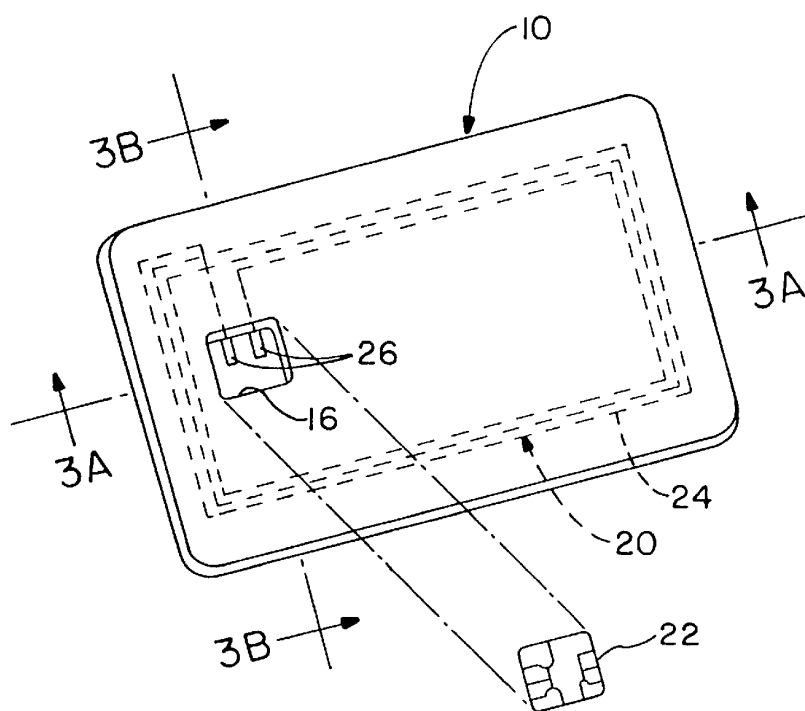
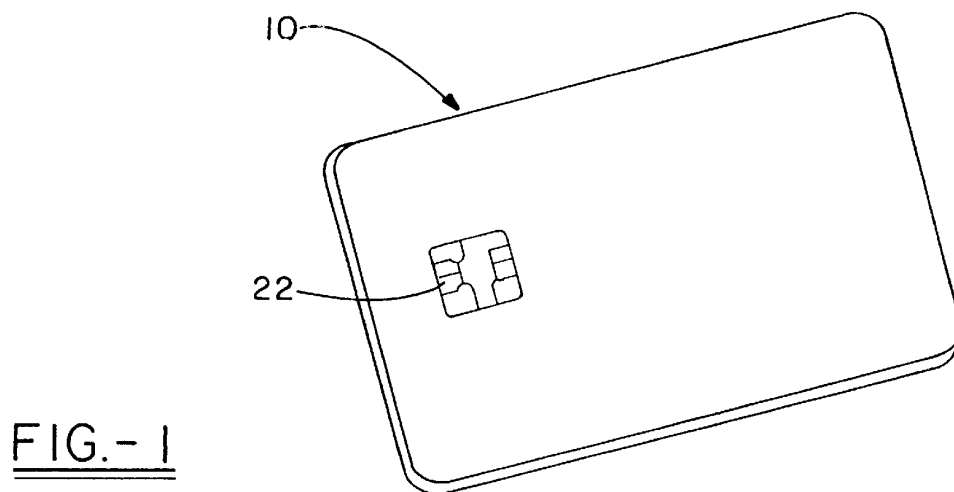


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FIG.-2A

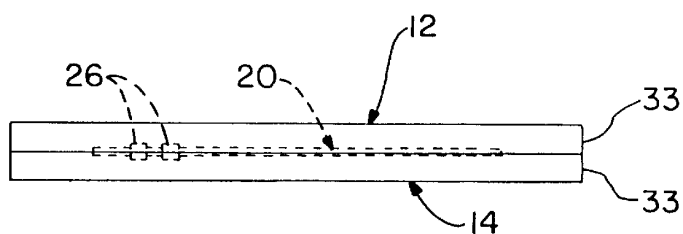


FIG.-3A

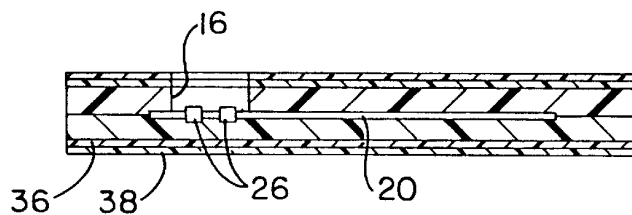


FIG.-3B

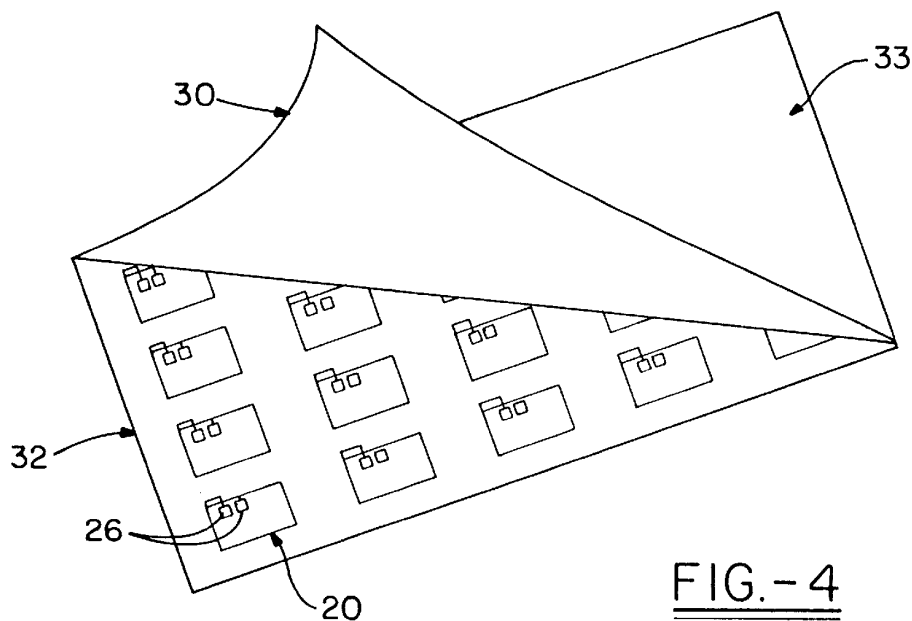
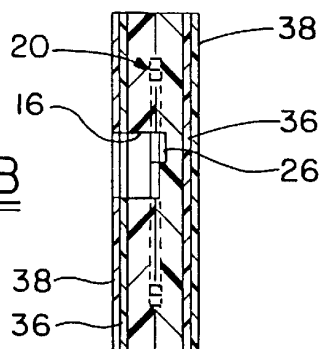
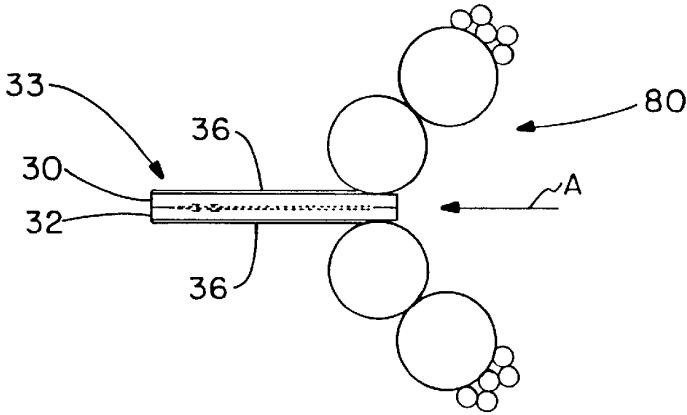
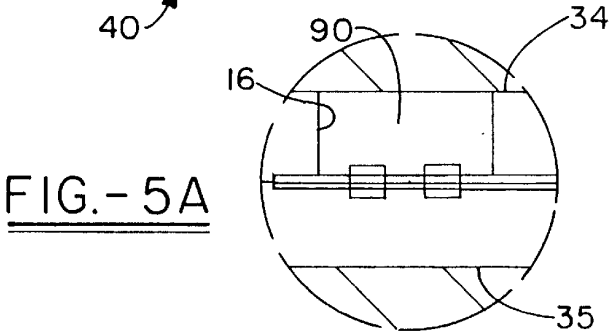
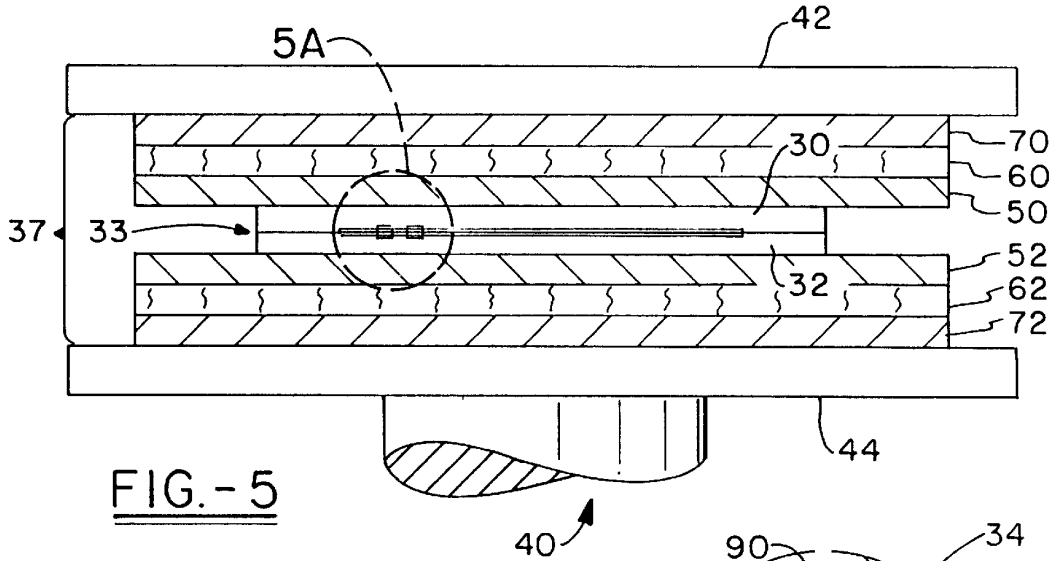
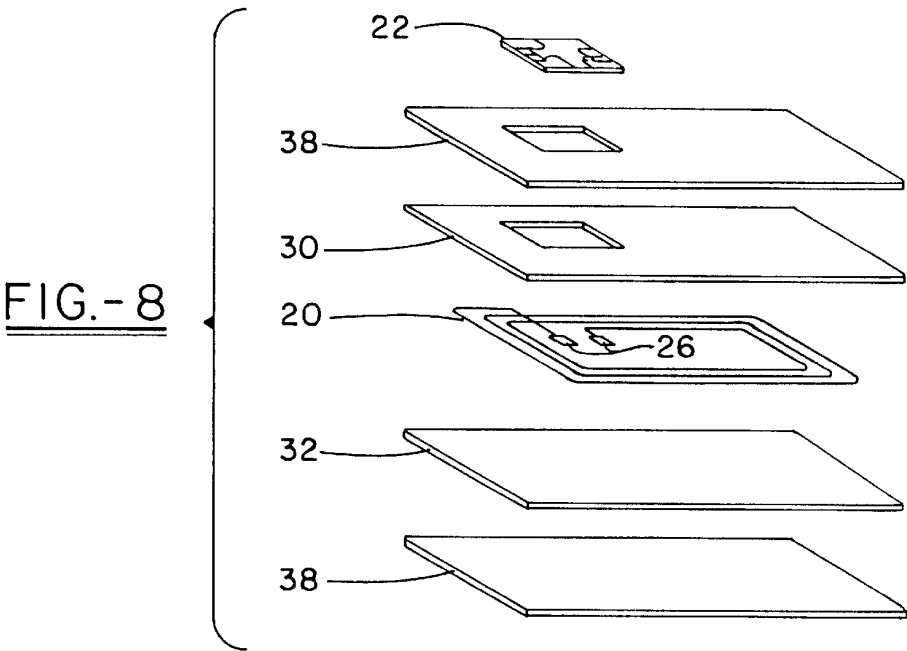
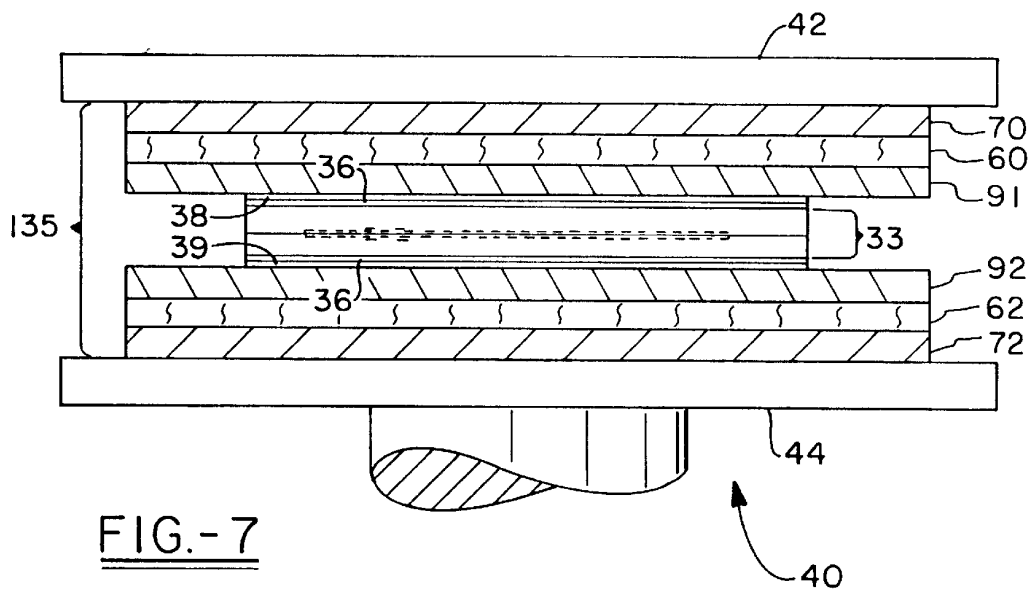


FIG.-4





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**HOT LAMINATION PROCESS FOR THE
MANUFACTURE OF A COMBINATION
CONTACT/CONTACTLESS SMART CARD**

This application is a continuation of application 08/918, 582, filed Aug. 19, 1997, now U.S. Pat. No. 6,036,099, which claimed the benefit of provisional application Ser. No. 60/024,255, filed Aug. 21, 1996; a continuation-in-part of application Ser. No. 08/727,789 filed Oct. 7, 1996, now U.S. Pat. No. 5,817,207, which claimed the benefit of provisional application Ser. No. 60/005,685, filed on Oct. 17, 1995.

FIELD OF THE INVENTION

The present invention relates generally to plastic cards and the manufacture thereof by a hot lamination process, and more particularly to smart cards and the manufacture of these such that they conform to industry size and performance standards and conventions and that have a superior outer surface as compared to known smart cards such that the card may receive dye sublimation printing or the like. Even more specifically, the preferred embodiments of the present invention relate to dual function cards containing imbedded electronic elements as well as an exposed electronic contact surface.

BACKGROUND OF THE INVENTION

As the use of plastic cards for credit cards, automated teller machine (ATM) cards, identification cards, and like continues to become more widespread, the problems associated with the use of such cards correspondingly increase. Credit card fraud and identification card fraud are becoming larger problems everyday, and this fraud has introduced uncertainties into our systems of commerce and our security systems. Using easily available technology, criminals are able to manufacture credit/debit cards, ATM cards, identification cards, and the like having another's account code, identification code, or other personal information embedded in the magnetic stripe thereof. Thus, for example, criminals may steal hundreds or thousands of legitimate credit card account numbers and manufacture many additional cards bearing the stolen information. These fraudulent cards are then usable by the criminals to purchase goods and to receive cash with the legitimate card holder and the card issuer left holding the bill.

Likewise, so called debit cards are becoming increasingly popular. These cards have stored thereon a certain amount of value for which the card owner has previously paid. For example, a subway rider may purchase a card good for X fares, with one fare being deducted from the card each time the owner rides the subway. Criminals have also been able to manipulate the data stored on these cards to defraud the merchants and others.

The ease in which criminals have been able to manufacture and or manipulate known cards results from the existence of the easily altered magnetic stripe storage medium used by known cards. These magnetic stripes are easily programmed and reprogrammed using commonly available technology. Thus, there has been found a need in the plastic card industry to provide a more secure plastic card that is very difficult or impossible to fraudulently manipulate.

The likely successor to magnetic stripe cards is known as a memory or smart card. A smart card can generally be described as a card having an integrated circuit with memory that is capable of making decisions. The category of smart cards can be further divided into subcategories based on the type of memory or type of communication with an associ-

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ated card reader. Types of smart cards include contact cards (cards requiring physical touch between the terminal reader and the surface of the card) and contactless cards (cards which interact with the terminal reader using an electromagnetic coupling). Contactless cards may also be referred to as "proximity" cards. This technology may serve as a substitute for or be provided as an addition to the magnetic stripe on a card.

One specific type of smart card is a dual function contact/contactless microprocessor chip plastic card commonly referred to in the industry as a dual function card. This card utilizes a single microprocessor to control both physical contact and proximity features of the card.

While these smart cards have been found to have infinitely more capability than magnetic stripe cards as well as being more successful in preventing or limiting fraud, they are more difficult and expensive to manufacture relative to ordinary magnetic stripe cards. One of the biggest obstacles to the wide spread manufacture and use of smart cards has been the inability of card manufacturers to manufacture a smart card that meets all industry standards and specifications, such as those set by the International Standards Organization (ISO), that are sufficiently aesthetically pleasing (wherein the embedded electronics are hidden from view), and that have a sufficiently regular or flat surface such that one or both surfaces of the card may be printed on using the very popular and widespread dye sublimation technology.

Limitations to known plastic cards with embedded computer chips and electronics are that they a) are too thick to work in connection with existing card reading machinery (ATM machines, telephones), b) have a surface that is too irregular to properly and consistently receive dye sublimation printing, c) utilize manufacturing processes making the cards cost prohibitive. Moreover, prior attempts to manufacture a sufficiently thin plastic card including a computer chip embedded therein have resulted in a card with inferior aesthetic qualities such as the ability to see the embedded computer chip through the plastic.

Furthermore, due to the presence of both internal and surface electronics within the card, the manufacture of a dual function card presents its own unique set of obstacles and problems, different from the manufacture of cards with fully embedded electronics.

SUMMARY OF THE INVENTION

The present invention is therefore directed to a hot lamination method for the manufacture of a plastic card having at least one electronic element embedded therein as well as at least one electronic element with an exposed contact surface and to such plastic cards. The card has an overall thickness in the range of 0.028 inches to 0.032 inches and comprises a plastic core having at least one electronic element embedded therein with at least one of the upper and lower surfaces of the core comprising a coating printed or otherwise applied thereon. A portion of the card's outer surface exposes a contact surface electronic element operatively connected to the card's internal electronics. An over-laminate film is preferably provided over the coated surface of the core and the resulting card has a variation in thickness across the surfaces thereof of no greater than approximately 0.0005 inches.

The hot lamination method of the present invention comprises the steps of providing upper (first) and lower (second) plastic core sheets, positioning at least one electronic element between the first and second core sheets to

thus form a core, and placing the core in a laminator and closing the laminator with minimal or no laminator ram pressure applied to the core. A heat cycle is applied to the core sheets in the laminator to cause complete or partial flow of the plastic sheets. The laminator ram pressure is then increased in combination with the heat. A cooling cycle is then applied to the core in the laminator, preferably with an associated increase in ram pressure, and the core is removed from the laminator.

In the preferred embodiment, the laminated core next undergoes a controlled depth milling operation to expose one or more contact pads which comprise part of the internal, embedded electronic element.

In alternative embodiments, one of the plastic sheets contained a pre-formed window which is positioned over the contact pads, prior to lamination. A spacer, integral to the corresponding platen or separate therefrom, is utilized to prevent or limit the flow of plastic into the window region so as not to coat the contact pads with plastic during the card manufacturing process.

At least one surface of the core is then printed on using a printing press or similar printing apparatus, a sheet of overlamine film is placed on at least one side of the core, and the core is once again placed in a laminator. A heat cycle is applied to the core with its overlamine film, and a cooling cycle is thereafter applied, resulting in a sheet of plastic card stock from which one or more cards may be cut.

Contact surface elements are installed into the window region of a plastic card and in operable contact with contact pads.

The invention is also directed to a card manufactured in accordance with the above process which results in a plastic card having a thickness in the range of approximately 0.028 inches to 0.032 inches with a surface smoothness of at least approximately 0.0005 inches as is required by International Standards Organization (ISO) and American National Standards Institute (ANSI) standards.

The present invention provides numerous advantages over known plastic cards and known plastic card manufacturing processes, and includes the formation of a plastic card with electronic elements such as a computer chip embedded therein with a pleasing aesthetic appearance, having a sufficiently smooth and regular surface such that the card may receive dye sublimation printing, and possessing sufficient durability and characteristics to comply with all industry specifications and standards.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a plastic card in accordance with the present invention;

FIG. 2 is a perspective view of the card shown in FIG. 1, illustrating the embedded and exposed electronics incorporated into the card;

FIG. 2A is a side elevational view of the card core illustrating various electronic elements that may be embedded in a card in accordance with the present invention;

FIG. 3A is a cross sectional view of the card illustrated in FIG. 2, taken through section line 3A—3A.

FIG. 3B is a cross sectional view of the card illustrated in FIG. 2, taken through section line 3B—3B.

FIG. 4 is a perspective view of a plurality of electronic elements positioned on a sheet of plastic core stock and covered by a second sheet of plastic core stock.

FIG. 5 is a schematic cross sectional view illustrating a book comprising the core, containing electronics, as positioned in a laminator;

FIG. 5A is an enlarged cross-sectional view of the portion encircled in FIG. 5 for an alternative embodiment, utilizing a spacer, for producing a card according to the present invention;

FIG. 6 schematically illustrates the process of printing on the core;

FIG. 7 is a schematic cross sectional view illustrating the core with overlamine film, as placed in a laminator;

FIG. 8 is an exploded view of a plastic card produced by the process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a plastic card including at least one electronic element embedded therein. The present invention also relates to a hot lamination process for the manufacture of plastic cards, and more particularly to a hot lamination process for the manufacturer of plastic cards that include an electronic element, such as a computer chip or other electronic element embedded therein. The electronic element may perform a wide variety of functions and take a wide variety of forms. Such cards, without regard to the particular electronic element embedded therein, will hereinafter be referred to as smart cards. The present invention also relates to a card formed in accordance with the invention.

In its preferred embodiment and as illustrated in FIGS. 1 and 2, the present invention relates to the manufacture of a dual function card, a particular type of smart card which utilizes a dual function contact/contactless microprocessor chip, as described previously herein. However, it will be appreciated by those skilled in the art, that the method of hot lamination described herein could easily be applied to other identity card or smart card applications.

Referring now to FIGS. 1, 2, and 2A there can be seen a plastic card 10 manufactured in accordance with the present invention and including an electronic element, generally 20, embedded therein. Card 10 includes an upper surface 12 and a lower surface 14. Electronic element 20 may take a wide variety of forms (microprocessor chip, circuit board, transponder, etc.) and perform a wide variety of functions. As shown in FIGS. 2, 2A, and 3A, electronic element 20 may comprise a read/write micro-chip 22 including a wire antenna 24 connected thereto, any other suitable electronic element. These electronic elements 20, 22 and 24 and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements embedded therein such that the cards 10 are of a superior quality, meet all ISO and other industry specifications and standards, and are sufficiently smooth and otherwise is capable of receiving dye sublimation printing. Electronic elements such as these described are available from manufacturers such as Motorola and Philips Electronics.

Upper surface 12 contains a window or cavity 16 formed therein and intended to expose one or more contact pads 26 operatively connected to antenna 24. Upon formation of card 10 in accordance with the preferred embodiment, a microprocessor chip 22 is inserted into window 16 and in electrical connection with contact pads 26. This microprocessor chip may function as a "proximity" or radio frequency identification (RFID) card in conjunction with antenna 24 when electromagnetically used with a compatible terminal reader. Microprocessor chip 22 is also capable of function as a contact card, requiring physical contact between a compatible terminal reader and the surface of chip 22. It should be appreciated that the contact function of the card may be accomplished by any contact sensor whether

integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of the microprocessor chip 22 surface as well as to the surface of plastic portion of card 10. It is to be appreciated that cards having a thickness greater than 0.032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in FIG. 4, one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20, including contact points 26, between first and second sheets of card stock 30, 32 to form a core 33. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32. When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32, electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in FIG. 5, laminator 40 includes upper and lower platens 42,44 for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42,44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads of 60, 62 and the entire assembly forms a book 37 for being positioned in laminator 40 between platens 42, 44.

Once book 37 is positioned in laminator 40 as shown in FIG. 5, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book 37. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens 42,44 up to a range of 275° F. to 400° F., and most preferably up to a range of 300° F. to 370° F. for a

period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

Once the heat cycle has been applied to book 37 as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 become encapsulated thereby, and so that sheets 30, 32 form a uniform core 33 with upper and lower surfaces 34,35. The ram pressure translates into an effective pressure on core 33 in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core 33, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates 50,52 provides surfaces 34, 37 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10–15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core 33 surface, was applied for 10–15 minutes to form a uniform core 33, using sheets 30,32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 35 during which time the ram pressure of the laminator 40 is increased, preferably by approximately 10–40% and most preferably about 25% until the platens 42,44 have cooled so as to return the core material to a solid state. In the preferred method the platens 42, 44 are cooled to approximately 40° F. to 65° F. for approximately 10–15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in FIG. 6, core 33 is coated on at least one of its upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in FIG. 6, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 can also serve to cosmetically hide the one or more electronic elements 20 that are embedded within core 33, and prevent these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to FIG. 7, the final preferred, but optional processing of core 33, which now comprises a layer of ink

36 or the like on at least one surface 34, 35 thereof, is schematically illustrated. An overlamine layer such as clear overlamine film 38 is positioned on at least one ink coated surface 34, 35 of core 33, and preferably core 33 is positioned between two similar sheets of overlamine film 38, 39 as shown. Overlamine film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is schematically illustrated in FIG. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlamine film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 91, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to FIG. 7.

When book 135 is positioned between upper and lower platens 42, 44 of laminator 40 as shown in FIG. 7, the laminator is closed and a heat cycle in the range of 175° F. to 300° F., and most preferably in the range of 180° F. to 275° F., is applied to book 135 for a period of 10 to 25 minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250–350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlamine layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40° F. to 65° F. and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlamine layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlamine layer 38 and should not cause softening or re-flow of plastic core 33. In lieu of this preferred overlamination process, it is to be understood that colorfast inks may not require an overlamine layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34, 35 thereof covered by a layer of ink 36, and with at least one surface 34, 35 thereof covered by a layer of overlamine film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34, 35 with a layer of ink 36 which is positioned between layers of overlamine film 38, 39, all of which has been laminated together as described and as shown in FIG. 8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12, 14 at preferably both surfaces 12, 14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy) or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26 and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in FIG. 5a, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon®. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims. For example, it should be understood that the methods as described can be performed with or without the printing or coating steps and still fall within the scope of the invention.

What is claimed is:

1. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:

- (a) providing first and second plastic core sheets;
- (b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;
- (c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:
 - (i) heating said core for a first period of time;
 - (ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;

(iii) cooling said core while applying a second pressure to said core, the second pressure being at least 10% greater than the first pressure; and

(d) milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said at least one electronic element.

2. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said laminator apparatus has first and second laminating plates, at least one of said first and second laminating plates having a matte finish for creating a textured surface on at least one of said outer surfaces of said core.

3. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 2, wherein each of said first and second laminating plates has a matte finish for creating said textured surface on both of said outer surfaces of said core.

4. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, each of said sheets having a thickness in the range of 0.007 to 0.024 inch.

5. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 4, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inch.

6. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said second pressure ranges from about 10% to about 40% greater than said first pressure.

7. A process as recited in claim 1 having a further step following step(c), said step comprising: positioning a layer of overlamine film on at least one of said surfaces of said core, positioning said overlamine film and said core in a laminator apparatus and laminating said layer of overlamine film to said core in said laminator to thereby form a sheet of plastic card stock.

8. The process of claim 7, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlamine film on said at least one surface of said core.

9. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said core is heated in step (c)(i) to a temperature in the range of 275° F. to 400° F. and said first period of time is at least five (5) minutes.

10. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first pressure is approximately 450 p.s.i. and said second period of time is at least 10 minutes.

11. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein a coating step is carried out on at least one surface of said core utilizing a printing press.

12. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein a coating step is carried out on at least one surface of said core utilizing a coating technique selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

13. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, having a further step after said step (c) comprising:

(a) positioning an overlamine film on said at least one surface of said core;

(b) subjecting said core to a heat and pressure cycle comprising the steps of:

(i) heating said core to a temperature between approximately 175° F. to 300° F. for approximately 10 to 25 minutes;

(ii) applying approximately 1000 p.s.i. pressure to said core; and

(iii) cooling said core to a temperature in the range of approximately 40° F. to 65° F. for approximately 10 to 25 minutes.

14. The process of claim 13, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlamine film on said at least one surface of said core.

15. A process as recited in claim 1 comprising the further step of inserting a second electronic element into said cavity, the second electronic element being in electrical communication with the at least one electronic element.

16. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board antenna or an associated wire antenna.

17. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

18. The process according to claim 1, wherein the pressure on said core in step (c)(i) is less than 10 p.s.i.

19. The process according to claim 1, wherein said core is heated in step (c)(ii).

20. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:

(a) providing first and second plastic core sheets;

(b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;

(c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:

(i) heating said core for a first period of time;

(ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;

(iii) cooling said core while applying a second pressure to said core, the second pressure being at least 10% greater than the first pressure.

21. The process according to claims 20, further comprising:

forming a cavity in said core.

22. The process according to claim 21, wherein the step of forming a cavity in said core comprises:

after step (c), milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said at least one electronic element.

23. The process according to claim 22, further comprising:

inserting a second electronic element into said cavity, the second electronic element being in electrical communication with the at least one electronic element.

* * * * *

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

08/12/1999 TRADE1 00000029 09360846

01 FC:201	380.00 DP
02 FC:203	36.00 DP

PTO-1556
(5/87)

*U.S. GPO: 1988-433-214/50404

OCS_C_045397

SERIAL NUMBER	09/368,846	FILING DATE	08/05/99	CLASS	235 156	GROUP ART UNIT	2846 1733	ATTORNEY DOCKET NO.	8014*2=CON		
APPLICANT	KEITH R. LEIGHTON, LORAIN, OH:										
<p>**CONTINUING DOMESTIC DATA*****</p> <p>VERIFIED THIS APPLN IS A CON OF 08/918,582 08/19/97 PAT 6036099 AND A CIP OF 08/727,789 10/07/96 PAT 5,817,207</p> <p><i>OK</i> PROVISIONAL APPLICATION NO. 60/005,685 10/17/95 PROVISIONAL APPLICATION NO. 60/024,255 08/21/96</p> <p>**371 (NAT'L STAGE) DATA*****</p> <p>VERIFIED <i>NONE</i></p> <p><i>OK</i></p> <p>**FOREIGN APPLICATIONS*****</p> <p>VERIFIED <i>NONE</i></p> <p><i>OK</i></p> <p>IF REQUIRED, FOREIGN FILING LICENSE GRANTED 08/30/99 ** SMALL ENTITY **</p>											
Foreign Priority claimed		35 USC 119 (a-d) conditions met		<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Met after Allowance		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Verified and Acknowledged		<i>OK</i>		Examiner's Initials		Initials		OH	4	24	2
ADDRESS	SEE CUSTOMER NUMBER: 021324										
TITLE	HOT LAMINATION PROCESS FOR THE MANUFACTURE OF A COMBINATION CONTACT/CONTACTLESS SMART CARD AND PROCESS RESULTING THEREFROM <i>OK</i> 10/9/02										
FILING FEE RECEIVED	\$481		FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT NO. _____ for the following:				<input type="checkbox"/> All Fees <input type="checkbox"/> 1.18 Fees (Filing) <input type="checkbox"/> 1.17 Fees (Processing Ext. of time) <input type="checkbox"/> 1.18 Fees (Issue) <input type="checkbox"/> Other <input type="checkbox"/> Credit				

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JESSE U.S. PRO

Practitioner's Docket No. 6014-2-CON

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

66/50/80
JESSE U.S. PRO

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Keith R. Leighton

For (title): Hot Lamination Process for the Manufacture of a Combination Contact/Contactless Smart Card and Product Resulting Therefrom

1. Type of Application

This transmittal is for a continuation application.

2. Benefit of Prior U.S. Applications (35 U.S.C. 119(e), 120, or 121)

The new application being transmitted claims the benefit of prior U.S. applications. Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATIONS CLAIMED.

CERTIFICATION UNDER 37 C.F.R. 1.10*

(Express Mail label number is mandatory.)

(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date AUGUST 5, 1999, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL122138088US, addressed to the: BOX PATENT APPLICATION, Assistant Commissioner for Patents, Washington, D.C. 20231.

MARK A. WATKINS

(type or print name of person mailing paper)

[Signature]

Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

***WARNING:** Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).
"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

(Application Transmittal—page 1 of 4)

OCS_C_045399

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

16 Page(s) of Specification
 6 Page(s) of Claims
 4 Sheet(s) of Drawing(s)—Formal

B. Other Papers Enclosed 3 Page(s) of declaration and power of attorney
 1 Page(s) of abstract

4. Declaration or Oath Enclosed Executed by:
 • inventor.

5. Inventorship Statement The inventorship for all the claims in this application is the same.

6. Language English

7. Fee Calculation (37 C.F.R. 1.16) Regular Application

CLAIMS AS FILED					
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 CFR 1.16(a)
Total Claims (37 CFR 1.16(c))	24	- 20 =	4 x	\$18.00	\$72.00
Independent Claims (37 CFR 1.16(b))	3	- 3 =	0 x	\$78.00	\$0.00
Multiple Dependent Claim(s), if any (37 CFR 1.16(d))			+	\$260.00	\$0.00

Filing Fee Calculation \$832.00

8. Small Entity Statement(s)

Statement that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is attached.

Filing Fee Calculation (50% of above) \$416.00

(Application Transmittal—page 2 of 4)

9. Fee Payment Being Made at This Time Enclosed

Filing Fee	\$416.00
Total Fees Enclosed	\$416.00

10. Method of Payment of Fees

Check in the amount of \$416.00 is attached.

11. Instructions as to Overpayment

Credit Account No. 15-0450.

**ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF
PRIOR U.S. APPLICATIONS CLAIMED**

12. Relate Back

The specification has *already been* amended by inserting, before the first line, the following sentence: *This application is a continuation of copending application 08/918,582, filed August 19, 1997; a continuation-in-part of copending application 08/727,789 filed October 7, 1996, now U.S. Patent No. 5,817,207.*

A. 35 U.S.C. §§ 120, 121 and 365(c)

"The nonprovisional application designated above, namely application no. 08/727,789 now U.S. Patent No. 5,817,207; filed October 7, 1996, claims the benefit of U.S. Provisional Application Nos.:

APPLICATION NO.	FILING DATE
60/005,685	10/17/1995"

"The nonprovisional application designated above, namely application 08/918,582, filed August 19, 1997, claims the benefit of U.S. Provisional Application Nos.:

APPLICATION NO.	FILING DATE
60/024,255	08/21/1996"

13. Maintenance of Copendency of Prior Application

A. Conditional Petition for Extension of Time in Prior Application

A conditional petition for extension of time is NOT THOUGHT TO BE REQUIRED.

14. Further Inventorship Statement Where Benefit of Prior Application(s) Claimed

a. This application discloses and claims only subject matter disclosed in the prior

(Application Transmittal—page 3 of 4)

application whose particulars are set out above and the inventor in this application is the same.

15. **Small Entity (37 CFR § 1.28(a))**

Applicant has established small entity status by the filing of a statement in parent application 08/918,582 on August 19, 1997.

16. **NOTIFICATION IN PARENT APPLICATION OF THIS FILING**

A notification of the filing of this continuation is being filed in the parent application, from which this application claims priority under 35 U.S.C. § 120.


SIGNATURE OF PRACTITIONER

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Abstract

A plastic smart card, such as a card having a radio frequency identification (RFID) proximity function, including at least one electronic element embedded therein and a physical contact card function and the hot lamination process for the manufacture of this dual function smart card and other plastic cards including a micro-chip embedded therein. The process results in a card having a preferred overall thickness in the range of 0.028 inches to 0.032 inches with a surface suitable for receiving dye sublimation printing - the variation in card thickness across the surface should not exceed 0.0005 inches. A card manufactured in accordance with the present invention also complies with all industry standards and specifications. Also, the hot lamination process of the present invention results in an aesthetically pleasing card. The invention also relates to a plastic card formed in accordance with the hot lamination process of the present invention.

**HOT LAMINATION PROCESS FOR THE MANUFACTURE OF A
COMBINATION CONTACT/CONTACTLESS SMART CARD
~~AND PRODUCT RESULTING THEREFROM~~**

JMS
10-9-02

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This application is a continuation of copending application 08/918,582, filed August 19, 1997; a continuation-in-part of copending application 08/727,789 filed October 7, 1996, now U.S. Patent No. 5,817,207.

Field of the Invention

The present invention relates generally to plastic cards and the manufacture thereof by a hot lamination process, and more particularly to smart cards and the manufacture of these such that they conform to industry size and performance standards and conventions and that have a superior outer surface as compared to known smart cards such that the card may receive dye sublimation printing or the like. Even more specifically, the preferred embodiments of the present invention relate to dual function cards containing imbedded electronic elements as well as an exposed electronic contact surface.

Background of the Invention

As the use of plastic cards for credit cards, automated teller machine (ATM) cards, identification cards, and like continues to become more widespread, the problems associated with the use of such cards correspondingly increase. Credit card fraud and identification card fraud are becoming larger problems everyday, and this fraud has introduced uncertainties into our systems of commerce and our security systems. Using easily available technology, criminals are able to manufacture credit/debit cards, ATM cards, identification cards, and the like having another's account code, identification code, or other personal information embedded in the magnetic stripe thereof. Thus, for example, criminals may steal hundreds or thousands of

legitimate credit card account numbers and manufacture many additional cards bearing the stolen information. These fraudulent cards are then usable by the criminals to purchase goods and to receive cash with the legitimate card holder and the card issuer left holding the bill.

Likewise, so called debit cards are becoming increasingly popular. These cards have stored thereon a certain amount of value for which the card owner has previously paid. For example, a subway rider may purchase a card good for *X* fares, with one fare being deducted from the card each time the owner rides the subway. Criminals have also been able to manipulate the data stored on these cards to defraud the merchants and others.

The ease in which criminals have been able to manufacture and or manipulate known cards results from the existence of the easily altered magnetic stripe storage medium used by known cards. These magnetic stripes are easily programmed and reprogrammed using commonly available technology. Thus, there has been found a need in the plastic card industry to provide a more secure plastic card that is very difficult or impossible to fraudulently manipulate.

The likely successor to magnetic stripe cards is known as a memory or smart card. A smart card can generally be described as a card having an integrated circuit with memory that is capable of making decisions. The category of smart cards can be further divided into subcategories based on the type of memory or type of communication with an associated card reader. Types of smart cards include contact cards (cards requiring physical touch between the terminal reader and the surface of the card) and contactless cards (cards which interact with the terminal reader using an electromagnetic coupling). Contactless cards may also be referred to as

"proximity" cards. This technology may serve as a substitute for or be provided as an addition to the magnetic stripe on a card.

One specific type of smart card is a dual function contact/contactless microprocessor chip plastic card commonly referred to in the industry as a dual function card. This card utilizes a single microprocessor to control both physical contact and proximity features of the card.

While these smart cards have been found to have infinitely more capability than magnetic stripe cards as well as being more successful in preventing or limiting fraud, they are more difficult and expensive to manufacture relative to ordinary magnetic stripe cards. One of the biggest obstacles to the wide spread manufacture and use of smart cards has been the inability of card manufacturers to manufacture a smart card that meets all industry standards and specifications, such as those set by the International Standards Organization (ISO), that are sufficiently aesthetically pleasing (wherein the embedded electronics are hidden from view), and that have a sufficiently regular or flat surface such that one or both surfaces of the card may be printed on using the very popular and widespread dye sublimation technology.

Limitations to known plastic cards with embedded computer chips and electronics are that they a) are too thick to work in connection with existing card reading machinery (ATM machines, telephones), b) have a surface that is too irregular to properly and consistently receive dye sublimation printing, c) utilize manufacturing processes making the cards cost prohibitive. Moreover, prior attempts to manufacture a sufficiently thin plastic card including a computer chip embedded therein have resulted in a card with inferior aesthetic qualities such as the ability to see the embedded computer chip through the plastic.

Furthermore, due to the presence of both internal and surface electronics within the card, the manufacture of a dual function card presents its own unique set of obstacles and problems, different from the manufacture of cards with fully embedded electronics.

Summary of the Invention

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The present invention is therefore directed to a hot lamination method for the manufacture of a plastic card having at least one electronic element embedded therein as well as at least one electronic element with an exposed contact surface and to such plastic cards. The card has an overall thickness in the range of 0.028 inches to 0.032 inches and comprises a plastic core having at least one electronic element embedded therein with at least one of the upper and lower surfaces of the core comprising a coating printed or otherwise applied thereon. A portion of the card's outer surface exposes a contact surface electronic element operatively connected to the card's internal electronics. An overlamine film is preferably provided over the coated surface of the core and the resulting card has a variation in thickness across the surfaces thereof of no greater than approximately 0.0005 inches.

The hot lamination method of the present invention comprises the steps of providing upper (first) and lower (second) plastic core sheets, positioning at least one electronic element between the first and second core sheets to thus form a core, and placing the core in a laminator and closing the laminator with minimal or no laminator ram pressure applied to the core. A heat cycle is applied to the core sheets in the laminator to cause complete or partial flow of the plastic sheets. The laminator ram pressure is then increased in combination with the heat. A cooling

cycle is then applied to the core in the laminator, preferably with an associated increase in ram pressure, and the core is removed from the laminator.

In the preferred embodiment, the laminated core next undergoes a controlled depth milling operation to expose one or more contact pads which comprise part of the internal, embedded electronic element.

In alternative embodiments, one of the plastic sheets contained a pre-formed window which is positioned over the contact pads, prior to lamination. A spacer, integral to the corresponding platen or separate therefrom, is utilized to prevent or limit the flow of plastic into the window region so as not to coat the contact pads with plastic during the card manufacturing process.

At least one surface of the core is then printed on using a printing press or similar printing apparatus, a sheet of overlamine film is placed on at least one side of the core, and the core is once again placed in a laminator. A heat cycle is applied to the core with its overlamine film, and a cooling cycle is thereafter applied, resulting in a sheet of plastic card stock from which one or more cards may be cut.

Contact surface elements are installed into the window region of a plastic card and in operable contact with contact pads.

The invention is also directed to a card manufactured in accordance with the above process which results in a plastic card having a thickness in the range of approximately 0.028 inches to 0.032 inches with a surface smoothness of at least approximately 0.0005 inches as in

required by International Standards Organization (ISO) and American National Standards Institute (ANSI) standards.

The present invention provides numerous advantages over known plastic cards and known plastic card manufacturing processes, and includes the formation of a plastic card with electronic elements such as a computer chip embedded therein with a pleasing aesthetic appearance, having a sufficiently smooth and regular surface such that the card may receive dye sublimation printing, and possessing sufficient durability and characteristics to comply with all industry specifications and standards.

Brief Description of The Drawings

Fig. 1 is a perspective view of a plastic card in accordance with the present invention;

Fig. 2 is a perspective view of the card shown in Fig. 1, illustrating the embedded and exposed electronics incorporated into the card;

Fig. 2A is a side elevational view of the card core illustrating various electronic elements that may be embedded in a card in accordance with the present invention;

Fig. 3A is a cross sectional view of the card illustrated in Fig. 2, taken through section line 3A-3A.

Fig. 3B is a cross sectional view of the card illustrated in Fig. 2, taken through section line 3B-3B.

Fig. 4 is a perspective view of a plurality of electronic elements positioned on a sheet of plastic core stock and covered by a second sheet of plastic core stock.

Fig. 5 is a schematic cross sectional view illustrating a book comprising the core, containing electronics, as positioned in a laminator;

Fig. 5A is an enlarged cross-sectional view of the portion encircled in Fig. 5 for an alternative embodiment, utilizing a spacer, for producing a card according to the present invention;

Fig. 6 schematically illustrates the process of printing on the core;

Fig. 7 is a schematic cross sectional view illustrating the core with overlamine film, as placed in a laminator;

Fig. 8 is an exploded view of a plastic card produced by the process of the present invention.

Detailed Description of the Invention

The present invention relates to a plastic card including at least one electronic element embedded therein. The present invention also relates to a hot lamination process for the manufacture of plastic cards, and more particularly to a hot lamination process for the manufacturer of plastic cards that include an electronic element, such as a computer chip or other electronic element embedded therein. The electronic element may perform a wide variety of functions and take a wide variety of forms. Such cards, without regard to the particular electronic element embedded therein, will hereinafter be referred to as smart cards. The present invention also relates to a card formed in accordance with the invention.

In its preferred embodiment and as illustrated in Figs. 1 and 2, the present invention relates to the manufacture of a dual function card, a particular type of smart card which utilizes a

dual function contact/contactless microprocessor chip, as described previously herein. However, it will be appreciated by those skilled in the art, that the method of hot lamination described herein could easily be applied to other identity card or smart card applications.

Referring now to Figs. 1, 2, and 2A there can be seen a plastic card 10 manufactured in accordance with the present invention and including an electronic element, generally 20, embedded therein. Card 10 includes an upper surface 12 and a lower surface 14. Electronic element 20 may take a wide variety of forms (microprocessor chip, circuit board, transponder, etc.) and perform a wide variety of functions. As shown in Figs. 2, 2A, and 3A, electronic element 20 may comprise a read/write micro-chip 22 including a wire antenna 24 connected thereto, any other suitable electronic element. These electronic elements 20, 22 and 24 and their insertion into plastic cards is not new, however, the present invention provides a new hot lamination process for manufacturing plastic cards 10 with these electronic elements embedded therein such that the cards 10 are of a superior quality, meet all ISO and other industry specifications and standards, and are sufficiently smooth and otherwise is capable of receiving dye sublimation printing. Electronic elements such as these described are available from manufacturers such as Motorola and Philips Electronics.

Upper surface 12 contains a window or cavity 16 formed therein and intended to expose one or more contact pads 26 operatively connected to antenna 24. Upon formation of card 10 in accordance with the preferred embodiment, a microprocessor chip 22 is inserted into window 16 and in electrical connection with contact pads 26. This microprocessor chip may function as a "proximity" or radio frequency identification (RFID) card in conjunction with antenna 24 when

electromagnetically used with a compatible terminal reader. Microprocessor chip 22 is also capable of function as a contact card, requiring physical contact between a compatible terminal reader and the surface of chip 22. It should be appreciated that the contact function of the card may be accomplished by any contact sensor whether integral to or physically separate from chip 22 and that window 16 may be formed anywhere on surfaces 12 and/or 14 as will accomplish the purposes of the invention.

Specifically, a card in accordance with the present invention has a thickness of approximately in the range of 0.028 inches to 0.032 inches with a surface smoothness of 0.0005 inches. In order to meet the ISO standards for such cards, these tolerances apply to the surface of the microprocessor chip 22 surface as well as to the surface of plastic portion of card 10. It is to be appreciated that cards having a thickness greater than .032 inches can easily be manufactured in accordance with the teachings herein while meeting all of the other criteria of the present invention. However, the foreseen product demand is for cards meeting the aforementioned standards.

As shown in Fig. 4, one or more cards 10 in accordance with the present invention may be manufactured by positioning an electronic element 20, including contact points 26, between first and second sheets of card stock 30, 32 to form a core 33. Preferably as shown, a plurality of cards are manufactured simultaneously, and accordingly a plurality of electronic elements 20 are positioned between the first and second sheets of plastic core stock 30, 32. When a plurality of electronic elements 20 are positioned between first and second sheets plastic core stock 30, 32,

electronic elements 20 are properly positioned relative to one another such that a plurality cards may be cut from the resulting card stock.

Plastic core sheets 30, 32 may be provided by a wide variety of plastics, the preferred being polyvinyl chloride (PVC) having a thickness in the range of 0.007 inches to 0.024 inches and preferably having a thickness of approximately 0.0125 inches each. Those skilled in the art will recognize that the thickness of the plastic core sheets will depend somewhat upon the thickness of the one or more electronic elements that are to be embedded therebetween if ISO standards are intended to be met. Other suitable plastics that may be utilized include polyester, acrylonitrile-butadiene-styrene (ABS), and any other suitable plastic.

Subsequent to placing one or more electronic elements 20 between the first and second sheets 30, 32 of plastic core stock to form a core 33, this core 33 is placed in a laminator apparatus 40 of the type well known in the art of plastic card manufacturing. As is shown in Fig. 5, laminator 40 includes upper and lower platens 42, 44 for applying ram pressure to an article positioned therebetween. In addition to the ability to apply ram pressure, laminator 40 is preferably of the type having controlled platens 42, 44 that may provide both heat and chill cycles and preferably includes cycle timer to regulate cycle time. Core 33 is positioned between first and second laminating plates 50, 52, one of which is preferably matte finished to provide laminated core 33 with at least one textured outer surface. First and second laminating pads 60, 62 are positioned outside of the laminating plates 50, 52, and first and second steel plates 70, 72 are likewise positioned outside of pads of 60, 62 and the entire assembly forms a book 37 for being positioned in laminator 40 between platens 42, 44.

Once book 37 is positioned in laminator 40 as shown in Fig. 5, the first lamination cycle is initiated by closing laminator platens 42, 44, preferably applying little or no ram pressure to book 37. This is preferably done using hydraulic pressure, and a pressure not to exceed about 10 pounds per square inch is believed sufficient for most applications.

A laminator heat cycle is initiated, bringing the temperature of platens 42,44 up to a range of 275°F to 400°F, and most preferably up to a range of 300°F to 370°F for a period of ranging between 1 to 20 minutes, but preferably greater than 5 minutes, and most preferably in the range of 7 to 10 minutes for PVC material. It must be understood that the temperatures recited herein are by means of example. The use of thermoplastic material other than PVC or the presence of pigments in the core material may require modification of the heat cycle temperature.

Once the heat cycle has been applied to book 37 as is set forth above, the ram pressure of laminator 40 is increased to facilitate the flow of the plastic core sheets 30, 32 so that the one or more electronic elements 20 become encapsulated thereby, and so that sheets 30, 32 form a uniform core 33 with upper and lower surfaces 34,35. The ram pressure translates into an effective pressure on core 33 in the range of 200 to 450 psi and preferably in the range of 250 to 350 psi. As can be expected temperature and pressure are inversely related to one another. In other words a lamination cycle at a higher temperature will require less pressure to be applied to core 33, and conversely a lower temperature heat cycle will require increased ram pressure. Damage to the electronic components can result from excessive ram pressure on the core while insufficient ram pressure will likely cause an inadequate flow of the plastic resulting in air pockets or an irregular card surface.

As mentioned, the use of matte finished laminator plates 50,52 provides surfaces 34, 37 with a slightly roughened or textured quality which will facilitate the application of a coating thereto as is discussed below. The ram pressure applied during the heat cycle and the length of the heat cycle may vary, depending especially upon the size of sheets 30, 32. For example, the cycle time may be in the range of 10-15 minutes. In one example, at a temperature of approximately 320 degrees Fahrenheit, a ram pressure of 940.135 pounds per square inch (p.s.i.), producing a pressure of about 275 psi at the core 33 surface, was applied for 10-15 minutes to form a uniform core 33, using sheets 30,32 of a size in the range of 12 inches by 24 inches to 24 inches by 36 inches.

Subsequent to the above heat cycle, laminator 40 applies a chill cycle to book 35 during which time the ram pressure of the laminator 40 is increased, preferably by approximately 10-40% and most preferably about 25% until the platens 42,44 have cooled so as to return the core material to a solid state. In the preferred method the platens 42, 44 are cooled to approximately 40°F to 65°F for approximately 10-15 minutes. Core 33 may then be removed from laminator 40 for additional processing.

Subsequent to the removal of core 33 from laminator 40, and as illustrated in Fig.6, core 33 is coated on at least one of its upper and lower surfaces 34, 35 with a layer of printing ink 36. This may be accomplished using a wide variety of printing techniques such as offset printing, letterpress printing, screen printing, roller coating, spray printing, litho-printing, and other suitable printing techniques. As shown in Fig. 6, core 33 is fed in the direction indicated with arrow A through a printing press, a lithographic printer, or a similar apparatus 80. This printing

step is performed to coat at least one surface 34, 35 of core 33 with a layer of aesthetically pleasing ink 36. This layer of ink 36 can also serve to cosmetically hide the one or more electronic elements 20 that are embedded within core 33, and prevent these one or more electronic elements 20 from showing through the relatively thin core 33. In this manner, the one or more electronic elements 20 encapsulated in core 33 are completely hidden from view without requiring the plastic used in the manufacture core 33 to be excessively thick (exceeding ISO standards for cards of this type).

Referring now to Fig.7, the final preferred, but optional processing of core 33, which now comprises a layer of ink 36 or the like on at least one surface 34, 35 thereof, is schematically illustrated. An overlamine layer such as clear overlamine film 38 is positioned on at least one ink coated surface 34, 35 of core 33, and preferably core 33 is positioned between two similar sheets of overlamine film 38,39 as shown. Overlamine film is very thin, for example in the range of 0.0015" thick. A book 135 is then constructed for insertion into laminator 40 as is schematically illustrated in Fig. 7. Book 135 comprising core 33, including at least one layer of ink 36 and at least one layer of overlamine film 38, 39 is positioned between laminating plates which are preferably highly polished plates such as mirror finished stainless steel plates 91, 92. Book 135 also comprises first and second laminating pads 60, 62 and first and second steel plates 70, 72 as is discussed above in relation to Fig. 7.

When book 135 is positioned between upper and lower platens 42, 44 of laminator 40 as shown in Fig. 7, the laminator is closed and a heat cycle in the range of 175°F to 300°F, and most preferably in the range of 180°F to 275°F, is applied to book 135 for a period of 10 to 25

minutes to produce a pressure on book 135 of between 200 to 450 psi, preferably 250-350 psi, with a ram pressure that varies depending upon sheet size or the ram size of the laminator 40, but which is typically approximately 1000 p.s.i. with an 18 inch diameter ram. This step causes the overlamine layer 38 to flow in order to produce a uniform protective layer over the printing.

The laminator 40 is then caused to execute a chill cycle, preferably with a corresponding increase in ram pressure. For example, the chill temperature may be in the range of 40°F to 65°F and last for a period of 10 to 25 minutes. However, any combination of temperature and time which permits the re-solidification of the overlamine layer 38 may be used. A ram pressure increase of approximately 10 to 40% over the pressure used for the heat cycle has been found to be preferable, with a pressure increase of approximately 25% being most desirable.

It is important to note that the use of pressure, or more significantly temperature, in the second lamination cycle should only affect the overlamine layer 38 and should not cause softening or re-flow of plastic core 33. In lieu, of this preferred overlamination process, it is to be understood that colorfast inks may not require an overlamine layer or that alternative overlaminates such as those applied by spray, silk screening or roll on may be used.

Subsequent to the above described second lamination cycle, a sheet of plastic card stock is provided which comprises at least core 33 with at least one surface 34, 35 thereof covered by a layer of ink 36, and with at least one surface 34,35 thereof covered by a layer of overlamine film 38, 39.

Preferably plastic card stock manufactured in accordance with the present invention comprises core 33 covered on both surfaces 34, 35 with a layer of ink 36 which is positioned

between layers of overlamine film 38, 39, all of which has been laminated together as described and as shown in Fig. 8. One or more cards 10 then may be cut from the resulting plastic card stock and card 10 will have a thickness in the range of 0.028 inches to 0.032 inches with variation in overall thickness across the surfaces 12, 14 thereof being no greater than approximately 0.0005 inches. The one or more cards 10 can thus be said to have a glossy surface smoothness of approximately 0.0005 inches or better. Thus, a card 10 manufactured in accordance with the present invention includes at least one surface 12, 14 at preferably both surfaces 12, 14 that are sufficiently smooth, glossy and regular to receive dye sublimation printing.

In the preferred embodiment, each card 10 undergoes a controlled-depth milling operation to form a window or cavity 16 and to expose one or more of the contact pads 26 connected to the antenna 24. Thereafter, a microprocessor chip 22 having a contact surface is inserted into the cavity and in electronic contact with contact pads 26. Chip 22 may be attached to contact pads 26 by known means such as conductive adhesives (including those cured by UV or sonic energy) or low temperature solder. The overall thickness of the card including the area occupied by chip 22 meets ISO standards and is capable of operation in compatible physical readers.

In an alternative embodiment, a cavity or window 16 is formed in the first or second sheet of plastic core stock, prior to the first lamination step. The core stock is positioned over the electronic element, generally 20, to expose one or more contact pads 26. This may also be done using electronic elements wherein microprocessor chip 22 is already attached to contact pads 26

and/or antenna 24 in which case the cavity is positioned over and around chip 22. As shown in Fig. 5a, a spacer 90 is inserted into cavity 16 and over contact pads 26 or chip 22. The spacer 90 may be integral to one of the matte laminating plates 50, 52 or separate therefrom and made of any suitable non-stick material such as Teflon®. Spacer 90 is utilized to prevent or limit the flow of plastic into cavity 16 during the lamination process so as not to cover contact pads 26 or chip 22 with plastic. When spacer 90 is non-integral with matte laminating plate 50 or 52 it may be removed or cut-away after either the lamination or overlamination process to expose cavity 16 and allow microchip 22 to be inserted therein and retained by such means as are known in the art, including solder or adhesives. In this embodiment where the chip is installed prior to lamination, when viewed in cross-section the outer surface of chip 22 is below the upper surface 34 or core sheet 35 prior to lamination, thus core sheets will accept the majority of applied pressure from the laminator. Spacer 90 provides further protection. As the core material softens, the plastic will flow around spacer 90 and chip 22 and the distance between the outer surface of chip 22 and the upper surface of core sheet 35 will decrease.

Those skilled in the art will recognize that the foregoing description has set forth the preferred embodiment of the invention in particular detail and it must be understood that numerous modifications, substitutions, and changes may be undertaken without departing from the true spirit and scope of the present invention as defined by the ensuing claims. For example, it should be understood that the methods as described can be performed with or without the printing or coating steps and still fall within the scope of the invention.

What is claimed is:

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1. A process for incorporating at least one electronic element in the manufacture of a plastic card, comprising the steps of:
 - (a) providing first and second plastic core sheets;
 - (b) positioning said at least one electronic element in the absence of a non-electronic carrier directly between said first and second plastic core sheets to form a core, said plastic core sheets defining a pair of inner and outer surfaces of said core;
 - (c) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:
 - (i) heating said core for a first period of time;
 - (ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;
 - (iii) cooling said core while applying a second pressure to said core.
 - (d) milling a region of said core to a controlled depth so as to form a cavity which exposes at least one contact pad of said electronic element.
 2. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said laminator apparatus has first and second laminating plates, at least one of said first and second laminating plates having a matte finish for creating a textured surface on at least one of said outer surfaces of said core.

3. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 2, wherein each of said first and second laminating plates has a matte finish for creating said textured surface on both of said outer surfaces of said core.

4. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first and second plastic core sheets are made from a material selected from the group consisting of polyvinyl chloride, polyester, and acrylonitrile-butadiene-styrene, each of said sheets having a thickness in the range of 0.007 to 0.024 inch.

5. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 4, wherein said first and second plastic core sheets have a thickness of approximately 0.0125 inch.

6. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said second pressure is greater than said first pressure.

6. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said second pressure ranges from about 10% to about 40% greater than said first pressure.

7. A process as recited in claim 1 having a further step following step(c), said step comprising: positioning a layer of overlamine film on at least one of said surfaces of said core, positioning said overlamine film and said core in a laminator apparatus and laminating

said layer of overlamine film to said core in said laminator to thereby form a sheet of plastic card stock.

9. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said core is heated in step (c)(i) to a temperature in the range of 275°F to 400°F and said first period of time is at least five (5) minutes.

10. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said first pressure is approximately 450 p.s.i. and said second period of time is at least 10 minutes.

11. The process of claim 1, further comprising the step of coating at least one of said surfaces of said core with a layer of ink.

12. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 11, wherein ^a ~~said~~ ^{on at least one surface of said core} coating step is carried out utilizing a printing press.

13. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 11, wherein ^a ~~said~~ ^{on at least one surface of said core} coating step is carried out utilizing a coating technique selected from the group consisting of silk screen printing, offset printing, letterpress printing, screen printing, roller coating, spray printing, and litho-printing.

14. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, having a further step after said step (c) comprising:

- (a) positioning an overlamine film on said at least one surface of said core;
- (b) subjecting said core to a heat and pressure cycle comprising the steps of:

(i) heating said core to a temperature between approximately 175°F to 300°F for approximately 10 to 25 minutes;

(ii) applying approximately 1000 p.s.i. pressure to said core; and

(iii) cooling said core to a temperature in the range of approximately 40°F to 65°F for approximately 10 to 25 minutes.

SUB 82 15. A process as recited in claim 1 comprising the further step of inserting an electronic contact element into said cavity.

16. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a micro-chip and an associated circuit board antenna or an associated wire antenna.

17. The process for incorporating at least one electronic element in the manufacture of a plastic card as recited in claim 1, wherein said at least one electronic element is a read/write integrated chip and an associated antenna.

18. A process for incorporating at least one electronic element having at least one electronic subcomponent in the manufacture of a plastic card, comprising the steps of:

(a) providing first and second plastic core sheets, at least one core sheet having a cavity formed therein;

(b) positioning said at least one electronic element in the absence of a non-electronic carrier between said first and second plastic core sheets to form a layered core, said plastic core sheets defining a pair of inner and outer surface of said core, and said cavity positioned so as to expose said at least one electronic subcomponent therein;

(c) inserting a spacer into said cavity, said spacer substantially filling said cavity and covering said at least one electronic subcomponent;

(d) positioning said core in a laminator apparatus, and subjecting said core to a heat and pressure cycle, said heat and pressure cycle comprising the steps of:

(i) heating said core for a first period of time;

(ii) applying a first pressure to said core for a second period of time such that said at least one electronic element is encapsulated by said core;

(iii) cooling said core while applying a second pressure to said core;

(e) removing said spacer from the cavity of said core.

19. A process as recited in claim 18, wherein said electronic subcomponent comprises one or more elements from the group consisting of a microprocessor chip, a contact pad, a transponder, and a contact sensor.

20. A plastic card constructed in accordance with claim 1.

21. A plastic card constructed in accordance with claim 18.

22. The process of claim 18, further comprising the step of coating at least one of said surfaces of said core with a layer of ink.

23. The process of claim 8, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlamine film on said at least one surface of said core.

¹⁴ 24. The process of claim ¹³ 14, further comprising the step of coating said at least one surface of said core with a layer of ink prior to positioning said overlamine film on said at least one surface of said core.

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Practitioner's Docket No. 6014-2-CON

PATENT

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,
CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is for a continuation application.

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (*if only one name is listed below*) or an original, first and joint inventor (*if plural names are listed below*) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

Hot Lamination Process for the Manufacture of a Combination Contact/Contactless Smart Card and Product Resulting Therefrom

SPECIFICATION IDENTIFICATION

The specification is attached hereto.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56.

(Declaration and Power of Attorney—page 1 of 3)

OCS_C_045426

CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(35 U.S.C. § 119(e))

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER	FILING DATE
60/005,685	10/17/1995
60/024,255	10/21/1996

CLAIM FOR BENEFIT OF EARLIER U.S./PCT APPLICATION(S)
UNDER 35 U.S.C. § 120

I hereby claim the benefit, under Title 35, United States Code, § 120, of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information that is material to patentability as defined in 37, Code of Federal Regulations, § 1.56 and that is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent, that occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 USC § 120:				
U.S. APPLICATIONS		STATUS		
U.S. APPLICATIONS	U.S. FILING DATE	Patented	Pending	Abandoned
1.0 /5,817,207	10/07/1996	X		
2.0 /08/918,582	08/19/1997		X	
PCT APPLICATION DESIGNATING THE U.S.				
PCT APPLICATION NO.	PCT FILING DATE	U.S. APPLICATION NOS. ASSIGNED (IF ANY)		

(Declaration and Power of Attorney—page 2 of 3)

OCS_C_045427

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Mark A. Watkins

Registration Number 33,813

I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:

Mark A. Watkins
(330) 864-5550

Mark A. Watkins
Oldham & Oldham Co., L.P.A.
1225 W. Market Street
Akron, OH 44313 USA

Customer Number 021324

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

Keith R. Leighton

Inventor's signature _____

Date _____

Country of Citizenship USA

Residence Lorain, OH

Post Office Address 2817 Fulmer Road
Lorain, OH 44053

(Declaration and Power of Attorney—page 3 of 3)

OCS_C_045428

Page 1 of 2

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR			Docket No. 6014-2
Serial No.	Filing Date	Patent No.	Issue Date
Applicant/ Patentee: Keith R. Leighton			
Invention: HOT LAMINATION PROCESS FOR THE MANUFACTURE COMBINATION CONTACT/CONTACTLESS SMART CARD AND PRODUCT RESULTING THEREFROM			
<p>As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:</p> <p><input checked="" type="checkbox"/> the specification to be filed herewith.</p> <p><input type="checkbox"/> the application identified above.</p> <p><input type="checkbox"/> the patent identified above.</p> <p>I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).</p> <p>Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:</p> <p><input checked="" type="checkbox"/> No such person, concern or organization exists.</p> <p><input type="checkbox"/> Each such person, concern or organization is listed below.</p> <p>*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)</p>			
<p>FULL NAME _____</p> <p>ADDRESS _____</p> <p style="text-align: center;"> <input type="checkbox"/> Individual <input type="checkbox"/> Small Business Concern <input type="checkbox"/> Nonprofit Organization </p>			
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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Keith LeightonSIGNATURE OF INVENTOR Keith R. LeightonDATE: 8-19-97

NAME OF INVENTOR _____

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PRINT OF DRAWINGS
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FIG.- 1

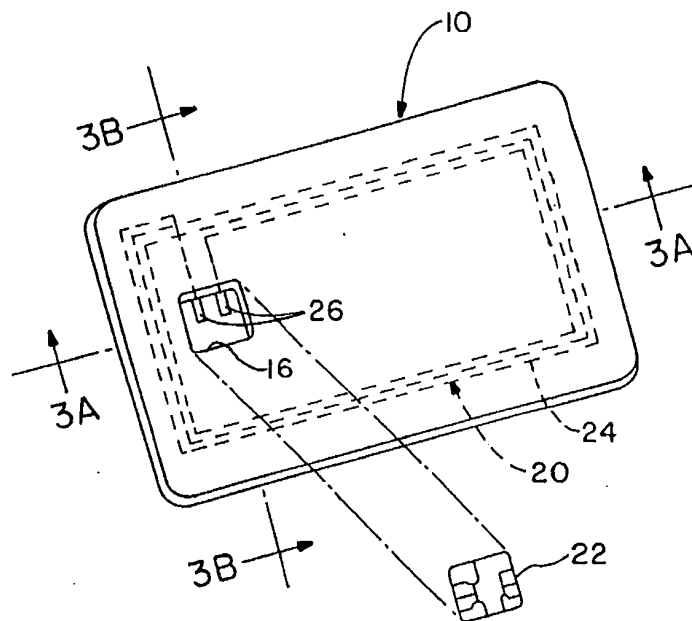
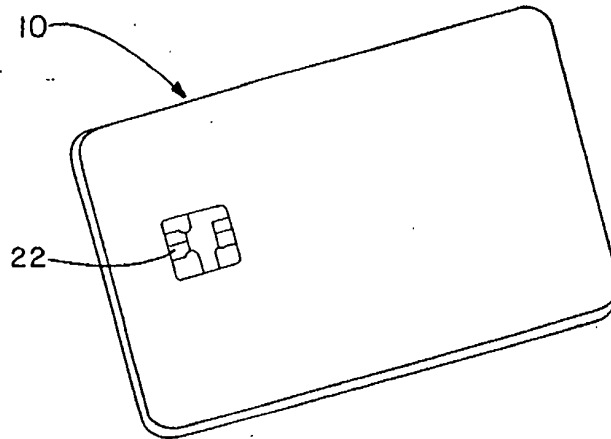


FIG.- 2

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FIG.-2A

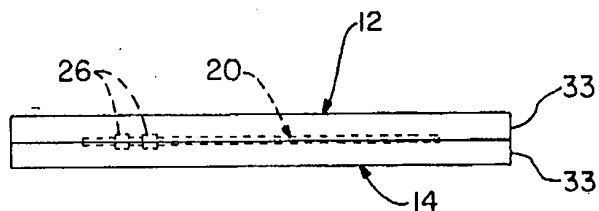


FIG.-3A

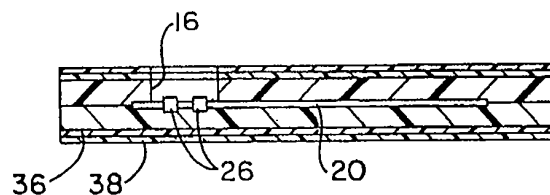


FIG.-3B

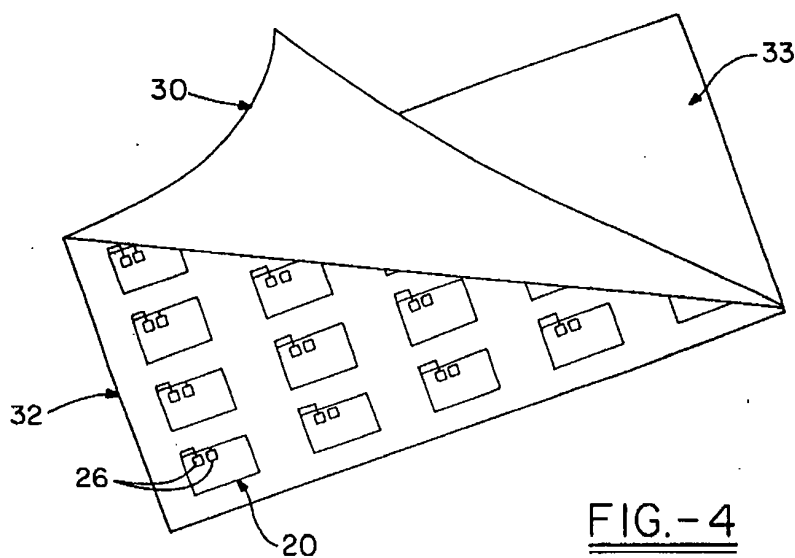
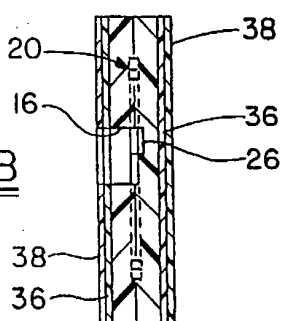


FIG.-4